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Original Research Report

Proximate and Sensory Properties of Snacks developed from African Yam Beans and African Rice Flour Blends for Household Consumption

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Abstract: The proximate and sensory properties of African yam beans (*Stephenostylis stenocarpa*) and African rice (*Oryza glaberrima*) snacks (queen cakes and chin-chin) were determined. African yam beans seeds and African rice grains flour were processed into flour and used as composite flour for snacks' production. The composite flour was mixed in the ratios of 100:0, 80:20, 50:50, 60:40, and 70:30, coded as samples: QCA,QC B, QC C, QC D and QCE (queen cakes) and CHA, CHB, CHC, CHD, and CHE (chin-chin). The proximate analysis indicated significant ($p<0.05$) increase in moisture contents (9.73 – 16.01%), ash (1.33-5.33%), fat (0.50-1.40%) and Protein (10.40 – 11.75) but decrease in carbohydrate (58.61-62.02%) for queen cakes. While an increase in ash (1.31 – 6.07%), fat (3.31 -11.23%), and protein (1.56 -11.14%) but decreased in moisture (5.16 – 8.16%) and carbohydrate (60.33 – 70.97%) was observed in chin-chin samples. The snack samples had good sensory scores and general acceptability. The present result recommended that African yam beans and African rice flour have high potential as value-added ingredients in queen cakes and chin-chin production for households; hence, incorporating them into the family menu will enhance its utilization and improve household food security.

Keywords: Chin-Chin, Flour, Proximate Analysis, Rice, Snacks

1. Introduction

Currently the need for sustainable development and economic recovery in Nigeria is a crucial matter particularly at the time Nigerians are battling with increase in food commodities and hunger which is further complicated by the effect of corona virus pandemic (FAO et al., 2021). Nigeria has several local food crops, including legumes, cereals, tuber crops, fruits and vegetables. Majority of these local crops are being neglected as a result of lack of information on its nutritional quality. In recent times most of these underutilized food crops are gaining popularity due to the fact that they possess quality nutrient that can be used to eliminate or reduce malnutrition and food insecurity among household and the country at large (Dandin & Krishna-Kumar, 2016). Households are relying on a few major crops, which is linked to consumption of a given diet, poor dietary intake, and malnutrition. The emergence of COVID-19 seemed to have worsened the existing vulnerability of communities contributing to high circumstances of acute malnutrition and food insecurity (Tan et al., 2020). Aside the global situation of hunger and malnutrition, the nutritional situation in Nigeria was already severe due to the insecurity and other forms of unrest in the country. Hence, improving global food and nutrition security will entail the need for diversification of various local food crops more especially, plant-based foods.

Queen cakes and chin-chin are confectionary products that are consumed widely by households as snacks. Snacks are defined as light quick meals usually eaten between the main meals intended to quench hunger or satisfy the consumers craving for its taste (Madukwe & Edeh, 2012). In view of Anozie, China and Beleya (2014), snacks are small meals eaten between meals in order to maintain health, while satisfying appetite. They are often smaller than the regular meals and are designed to be portable, quick and satisfying, less perishable and more durable than the prepared meals. Previously wheat flour has been used for the production of snacks like queen cakes and chin-chin due to the nature of its functional properties (Tharise, Julianti & Nurminah, 2014). In order to sustain the consumption of these snacks and reduce the importation of wheat flour, there is need to develop alternative source of flour as a substitute for wheat flour. Several authors have reported the use of locally available crops to substitute for wheat flour, the use of African yam beans and African rice has not been given adequate attention.

African yam beans (*Stephenostylis stenocarpa*) is a legume found in the tropical regions of the world. They belong to the same family leguminosea, it is the second most valuable source of protein used for human and animal nutrition. It is widely consumed in the south- eastern part of Nigeria (Idowu, 2014) and other parts of West Africa. The seed is very rich in protein of about 19 and 30% (Ade-Omowaye, Tucker & Smetanska, 2015, Doudu & Apea-Bah, 2017). African yam beans are also being consumed often by most patients with some chronic health conditions in Nigerian households. It is not easily damaged by pest on like other legumes both in cultivation and storage and it has the potential to meet year-round protein requirement if grown on a large scale (Idowu, 2014). The Amino acid analyses of African yam bean indicated that the lysine and methionine levels in the protein are equal to or better than, those of soybeans while most of the other essential amino acids corresponds to WHO/FAO recommendation. The presence of fiber, some useful starch and essential fatty acids, makes the crop good for development of new functional foods for consumer healthiness (George, Obilana & Oyeyinka, 2020).

Africa rice (*Oryza glaberrima*) is of the grass family poaceae. The most commonly cultivated rice is Oryza sativa and Oryza glaberrima. According to Okonkwo, Mgbakogu and Mbaeyi-Nwaoha, (2019), Oryza sativa and Oryza glaberrima plays an important role in improving food security in sub-

Saharan Africa where rice is used as a staple food crop that feeds over half of the global population. It is rich in carbohydrates, proteins, fatty acids and micronutrients. They contain antioxidants such as phenolic compounds (Okonkwo, Mgbakogu & Mbaeyi-Nwaoha, 2019). African rice is the leading provider of food calories in Nigeria; it can be used for products diversification such as boiling it and eaten with stew, steamed, processed into flour and made into noodles, bread and other products. The use of African yam bean and African rice in the production of snacks has not received adequate attention from researchers. There is need for product diversification and reevaluation in order to utilize these food crops properly.

1.1. Statement of Problem

Food insecurity in Nigeria has triggered efforts to finding possible alternative indigenous food that can be used to develop snacks which will help to augment the basic Nigerian food and also enhance the nutritional intake of individuals thereby reducing protein energy malnutrition. For optimal, stable and sustainable well being, there is need for alternative cheaper locally produced flour that can be used to substitute wheat flour and help to address certain health issues facing most families in Nigeria.

1.2. Purpose of the Study

The general purpose of this research was to develop snacks from composite flour of African yam beans and African rice. Specifically to:

(a) Determine the proximate composition of snacks (queen cake and chin-chin).
(b) Evaluate the sensory properties and general acceptability of the snack products.

1.3. Research Questions

The following research question guided the study

(a) What is the proximate composition of snacks developed from African yam bean and African rice flour blends?
(b) What are the sensory properties and the general acceptability of the snack products?

2. Materials and Methods

1.1. Design for the Study

This was a developmental study which involved African yam beans and Rice enhanced snack products being produced for households. The research was mainly experimental. Experimental research design according is centrally concerned with constructing research that is high in causal validity. The proximate analysis was carried out in the food science laboratory assisted by the laboratory technician while the acceptability testing was carried out in order to ascertain the acceptability of snacks enhanced with African yam beans. The sensory evaluation was carried out using 25 semi trained panelists from the department of home economics Michael Okpara University of agriculture.

2.1.1. Ethics Approval of Research

The ethical approval was given by Home Science Department, Michael Okpara University of Agriculture, Umudike.

2.2. Area of the Study

The experiment and sensory evaluation was carried out at the Home Economics Department Laboratory, Michael Okpara University of Agriculture Umudike, Abia state.

2.3. Population and Sample

A sample of 25 panelists consisting of 15 Home makers and 10 undergraduate students were

randomly selected from the home economics department, Michael Okpara University of Agriculture Umudike, Abia State.

2.4. Instrument for Data Collection and Study Procedure

2.4.1. Sources of Materials

African yam beans seeds, and rice grains were purchased from Eke Okigwe market, Imo state. Wheat flour and other ingredients used such as sugar, shortening, Eggs, salt, Nutmeg, baking powder, milk and flavorings were purchased at Ekeonuwa Douglas market, Owerri, Imo state.

2.4.2. Sample Preparation

African yam beans were cleaned, washed with tap water, and soaked for 10 hours. It was washed and dehulled, and the dehulled seeds were oven dried and then grinded into fine flour using a commercial mill and sieved through 150mm mesh sieve to obtain the flour and stored in an air tight container for further use. Rice grains were also cleaned, washed and drained out using a sieve, it was dried by hot air for 4 hours. The seeds were grinded using a commercial mill and sieved to obtain the flour, then stored in an air tight container for further use

2.4.3. Sample Formulation

Composite flour were formulated from processed seeds of African yam beans and Rice grains using the following ratios

Wheat flour (control): 1
80% African yam beans and 20% African Rice: 4:1
50% African yam beans and 50% African Rice: 1:1
60% African yam beans and 40% African Rice: 3:2
70% African yam beans and 30% African Rice: 7:3

2.4.4. Proximate Analysis procedure

The proximate analysis of the snack samples were determined in triplicate except for carbohydrate contents which was determined by difference. The standard method of Association of Official Analytical Chemist (Horwitz & Latimer, 2005) was used to determine the chemical composition of the samples.

2.4.5. Sensory Evaluation Procedure

The sensory properties of the snack samples such as color, texture, taste, flavor and general acceptability were evaluated using twenty five trained panelists (25) who are familiar with cake and chin-chin samples. A nine point hedonic scale was used for the sensory evaluation.

2.5. Data Collection Technique

Data was collected for every test and statistical analysis was done for both the proximate composition and sensory evaluation of the composite snack samples. The data was collected with the help of trained research assistant from the department of home science.

2.6. Data analysis Technique

The data collected was organized in the wide format into excel file and then converted into the extended format to make it easy for the statistical analysis soft ware to transmit data. All samples were in duplicates, descriptive statistic (mean, standard deviation and significance (P- value) were done for all samples. Data were sorted and recorded using Analysis of variance and SPSS version 26 (which is statistical package for social science) to separate the means at ($P \leq 0.05$).

3. Results and Discussion

Table 1: Proximate composition of Queen Cakes samples

Samples	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fiber (%)	Carbohydrate
QCA	9.73[c]	1.73[d]	11.50[b]	10.52[c]	0.50[d]	62.02[a]
QCB	15.00[b]	5.33[a]	7.00[c]	11.75[b]	0.76[c]	60.16[c]
QCC	16.01[a]	4.67[b]	9.00[d]	10.64[c]	1.40[c]	58.61[d]
QCD	12.39[d]	1.33[c]	13.00[a]	10.40[c]	0.88[b]	62.00[a]
QCE	12.44[c]	2.33[c]	11.30[c]	11.20[b]	0.89[b]	61.71[b]
LSD	0.02	0.02	0.02	0.02	0.02	0.02

Means with the same superscript in the same column are not significantly different (P<0.05)

Key: QCA=100% wheat flour, QCB= 80% African yam bean-20% African rice flour, QCC= 50% African yam beans = 50% African rice, QCD=60% African yam beans = 40%. African rice, QCE= 70% African yam beans= 30% African rice

3.1. Proximate composition of the composite Queen Cakes

Table 1 showed the proximate composition of queen cake composite flour and the control. The moisture content of the queen cakes differed significantly (P<0.05) from each other. Sample QCC had the highest value (16.01%) while QCA had the least value (9.73%). The increased moisture content may be attributed to the presence of African yam beans flour due to its water absorption capacity and protein content. This observation is in agreement with the work of Akubor and Ishiwu (2013). The ash content ranged from 1.33% to 5.33%, which was significantly different (P<0.05) from each other with sample QCB recording the highest value and QCD Recording the least value. The substitution level of African yam beans increased the ash content of the cake samples indicating that they will contain high mineral value. Similar report was observed by Akubor and Ishiwu (2013) in cakes supplemented with plantain peel flour. Significantly higher (P < 0.05) fat value (13.00%) was observed in QCD compared to other samples. The fat content of the cake samples differed from each other. The protein value of the composite cakes was higher than that of the control. An increase in protein was observed in the level of African yam bean addition. This is expected as African yam beans are noted for its high quality and quantity of protein. This agrees with previous reports on biscuits produced from wheat and African yam beans (Idowu, 2014). The fiber contents of the composite cakes and the control are not significantly different (P> 0.05) except for sample QCC (1.40%) which was higher than other samples. The queen cakes had carbohydrates ranging from 58.61% to 62.02%. There was no significant different (P> 0.05) between sample QCA (control) and sample QCD which also had the highest value. This implies that the cake samples are good sources of energy for normal body mechanism.

Table 2: Proximate composition of Chin-Chin samples

Samples	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Fiber (%)	Carbohydrate
CHA	8.16[a]	5.02[b]	3.31[c]	1.56[c]	1.00[c]	70.97[a]
CHB	5.16[c]	6.07[a]	11.23[d]	10.06[d]	0.73[d]	66.98[d]

CHC	6.24[c]	5.00[c]	10.11[b]	9.76[c]	1.89[a]	67.00[c]
CHD	8.04[b]	3.00[d]	10.06[c]	10.60[b]	0.63[c]	67.67[b]
CHE	5.55[d]	1.31[c]	8.67[d]	11.14[a]	1.31[b]	60.33[c]
LSD	0.02	0.02	0.02	0.02	0.02	0.02

Means with the same superscript in the same column are not significantly different (P<0.05)

Key: CHA=100% wheat flour, CHB= 80% African yam beans-20% African rice flour, CHC= 50% African yam beans = 50% African rice, CHD=60% African yam beans = 40%. African rice, CHE= 70% African yam beans= 30% African rice

3.2. Proximate composition of Chin-Chin

As shown in Table 2, the moisture content of the chin-chin samples ranged from 5.16 to 8.16, CHA (control) had the highest values while CHB recorded the least value. This implies that the composite formulations with lower moisture content will have longer shelf life than the control, since high moisture content encourages microbial growth. Hence lower moisture content of the chin-chin products ensures higher keeping quality and shelf life. The ash content of CHB had the highest ash content of 6.07% while sample CHE had the least ash content of 1.31%. The ash content values obtained from this study is within the range of 4.94% to 6.10% reported by Adegunwa, Ganiyu, Bakare and Adebowale (2014) for composite millet- wheat chin-chin. Fat content of the composite chin-chin samples was higher than the control chin-chin. This implies that the control chin-chin will last longer than the composite chin-chin since food with high fat content is bound to spoil faster compared to one with low fat content (Naiba et al., 2013). The fat content obtained from this study was higher than the ranges of 7.56% - 8.13% as reported by Adegunwa et al., (2014) for millet–wheat chin-chin. Low fat food products are less susceptible to rancidity and thereby encouraging more shelf stable (Idowu, 2014). The protein content of the chin-chin samples increased (1.56% - 11.14%) as the level of African yam beans substitution increased. This obviously could be attributed to the crude protein of the African yam beans. This implies that African yam beans and African rice flour could help in increasing the protein content in food products. The high protein values observed in this study, particularly in sample CHD and CHE shows that the composite snacks could be used as snacks for households which will improve their food security and malnutrition. A similar trend was observed by Idowu (2014) for development of biscuits from wheat and African yam bean flour blends. The fiber content of the chin-chin ranged from 0.63% - 1.89. The value obtained in this study was within the value of 1.16% – 4.00% as reported by Falola et al. (2014). The carbohydrate content of the control sample was higher than the composite chin-chin. This could be attributed to the fact that wheat has higher carbohydrate content than African yam bean. The range obtained in this study was similar to the range of 69.16% - 75.28% reported by Falola et al., (2014).

Table 3: Sensory evaluation of Queen Cake samples

Samples	Color	Texture	Taste	Flavor	General acceptability
QCA	8.40[a]	8.12[a]	8.12[a]	8.32[a]	8.60[a]
QCB	7.00[b]	6.92[b]	6.92[bc]	6.84[b]	7.20[b]
QCC	6.92[b]	7.00[b]	7.12[b]	7.20[bc]	7.04[b]
QCD	6.80[b]	6.68[b]	6.64[b]	6.56[b]	7.08[b]
QCE	6.64[b]	6.52[d]	6.32[c]	6.48[b]	7.08[b]
LSD	0.92	0.96	1.02	1.05	0.86

Means with the same superscript in the same column are not significantly different ($p<0.05$)

Key: QCA=100% wheat flour, QCB= 80% African yam bean-20% African rice flour, QCC= 50% African yam bean = 50% African rice, QCD=60% African yam bean = 40%. African rice, QCE= 70% African yam bean= 30% African rice

3.3. Sensory evaluation of Queen Cakes

The results of the sensory analysis in Table 3 showed that cakes developed with 100% wheat flour was most preferred in all the attributes analyzed, however the values obtained from cakes developed from African yam beans and African rice composite flour blends showed that the developed cakes were acceptable by the panelists as shown in table 3. An increase in sensory preference of texture, taste and flavor were observed up to 50% African yam beans and 50% African rice (QCC). Cakes developed from composite flour compared favorably with the control wheat flour. This shows that the composite snacks could be sustainable strategies in tackling malnutrition.

Table 4: Sensory evaluation of Chin-Chin samples

Samples	Color	Texture	Taste	Flavor	General acceptability
CHA	8.16[a]	7.56 [a]	8.04 [a]	7.92[a]	8.00 [a]
CHB	6.92 [b]	6.52[b]	6.72[b]	7.20 [b]	7.12 [b]
CHC	6.88[bc]	6.68 [b]	6.84[b]	7.04[b]	7.16[b]
CHD	6.44 [c]	6.36 [b]	6.44 [b]	6.52 [b]	6.84 [b]
CHE	7.48[b]	7.00[ab]	7.12[d]	6.60[b]	7.04[b]
LSD	0.82	0.96	0.95	1.00	0.79

Means with the same superscript in the same column are not significantly different ($p<0.05$)

Key: CHA=100% wheat flour, CHB= 80% African yam beans-20% African rice flour, CHC= 50% African yam beans = 50% African rice, CHD=60% African yam beans = 40%. African rice, CHE= 70% African yam beans= 30% African rice.

3.4. Sensory evaluation of Chin-Chin samples

The sensory result in Table 4 indicated that 100% wheat flour had the highest values in all the sensory attributes analyzed with the values of 8.16, 7.56, 8.04, 7.92 and 8.00 for color, texture, taste, flavor and general acceptability, respectively as shown in table 4. Color, texture and taste of the composite chin-chin (CHE) were observed to be higher than other samples. A decrease in sensory preference of color, texture, taste, flavor and general acceptability were observed up to 60% African yam bean and 40% African rice (QCD). However all the composite flour blends were accepted by the panelist.

The study was only conducted with home makers in Michael Okpara University of agriculture Umudike therefore the results are not representative of all the home makers in the area. The processes involve in processing African yam beans into flour is very stressful and time consuming. Enrichment and fortification of the composite blend with vitamins should be encouraged. Further research should be carried out on the shelf life of the composite flour to know if the composite flour can be preserve for a long period.

4. Conclusion

This study revealed that acceptable snacks could be developed from African yam bean and

African rice flour because the composite snack obtained posed a good and desirable nutritive value. The study showed that producing snack with legume and cereal crops could improve the nutritional composition and sensory attributes. African yam bean and African rice could be a promising cheap source of nutrients that are lacking in conventional snack products. Hence, the products would help to alleviate the problem of protein-energy malnutrition in Nigeria. Households should be enlightened on the importance of consuming these two indigenous crops. They should be taught how to process and produce composite flour using simple production technique. These can be achieved through formal and informal local information dissemination method. There should be food processing industries in all the communities. These industries should be equipped with functional machines. This will help to simplify work for home makers. Nutrition educators should be used to teach individuals and families the importance of consuming legumes and grains. This will help to prevent diseases, alleviate hunger and poverty.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

This work was carried out in collaboration between all authors. CIN and EPO designed the study, CIN performed the chemical analysis and wrote the first draft of the manuscript, EPO worked on the technical quality of the manuscript and its revision, and PEM supervised the project. All authors read and approved the final manuscript.

Data Availability Statement

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

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